

REMARKS

Claims 54-85 are pending in this application. Claims 57, 74 and 83 are amended to clarify the claimed invention. The amendments do not add new matter, and entry at this time is proper.

Favorable reconsideration and allowance of the present application are respectfully requested. The amendments, in conjunction with the following remarks, are believed to place the application in immediate condition for allowance. Entry of the amendments and favorable consideration of the application respectfully are requested in view of the foregoing amendments and the following remarks.

Though claims 57, 74 and 83 are amended, Applicants do not concede that the Office Action's statutory rejections are proper. The amendments are understood to not narrow the scope of the claimed invention, nor is it made for reasons related to patentability. Rather, the amendments are made to clarify the claimed invention. In fact, Applicants note that claim 57 was objected to, and the amendment to claim 57 is made in response to that objection and not to any statutory rejection. Thus, in future construction or interpretation, the amended claims should be entitled to a full range of equivalents.

Applicants note that the Information Disclosure Statement filed August 21, 2001, has not been considered. Applicants

respectfully request that the Examiner consider the Information Disclosure Statement, and provide Applicants with an initialed copy of PTO-1449 for their records.

Office Action

Claim 57 stands objected to allegedly because of informalities. Claims 54-73 and 83-85 stand rejected under 35 U.S.C. § 112, second paragraph, as allegedly indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. Claims 74 and 83-85 stand rejected under 35 U.S.C. § 102(b) as allegedly anticipated by Resonant Tunneling of Holes Through Silicon Barriers, J. Vac. Sci. Technol. B8(2), Mar/Apr 1990, pps. 210-213 (Gennser et al.). Claims 75-82 stand rejected under 35 U.S.C. § 103(a) as allegedly rendered obvious by Gennser in view of Diffusion of Sb in Relaxes Si_{1-x}Ge_x, Appl. Phys. Lett. 68 (19), 6 May 1996, pps. 2684-2686 (Larsen et al.). Applicants respectfully traverse the objection and rejections in view of the foregoing amendments and the following remarks.

Objection

Claim 57 is objected to for certain informalities. Applicants amend claim 57 in accordance with the Examiner's suggestion to correct the informalities. Thus, Applicants respectfully request that the Examiner withdraw the objection to claim 57.

Claims 54-73 and 83-85 Are Not Indefinite

Claims 54-73 and 83-85 are rejected as allegedly indefinite. The Office Action alleges that the subject claims fail to particularly point out and distinctly claim the subject matter that Applicants regard as their invention. The rejection is respectfully traversed.

Claims 54-57

Regarding claims 54-57, the Office Action alleges that the phrase "a top injector adjacent to, but not necessarily in direct contact with, the bottom injector" is unclear because this feature allegedly is not shown in the Figures. Applicants respectfully traverse.

Applicants direct the Examiner's attention to the Specification, which recites "[a]lthough the present invention has been described above in conjunction with the embodiments illustrated in FIGs. 1, 2, and 3 as well as variations therein, the present invention may also be varied in several other ways." Page 14, lines 9-11. Applicants note that the Specification discloses several variations of the embodiments shown by Figs. 1, 2, and 3, including embodiments where the top injector layer is formed in direct contact with the bottom injector. For example, the Specification recites that "tunnel barrier layer 65 may have a thickness of 0-50 nm, or more preferably 0-35 nm, 0-20 nm, 0-15 nm,

0.5-11.5 nm, 1-10, 2-6 nm, or 2-4 nm depending on the application."

Page 14, line 29-page 15, line 1.

The Specification also recites "[w]ith respect to spacer layers 60 and 70, these layers provide an offset for the central tunnel barrier and may have a thickness in the range 0-50nm, or more preferably in the range of 0-30 nm, 0-10nm, 0-5 nm, 0-3 nm, or 0 nm to 1 nm." Page 15, lines 1-3.

Moreover, with regard to the space between the top injector layer and the bottom injector layer, the Specification recites "[i]n the more preferred embodiments, the aggregate thickness of layers 60, 65, and 70, which is in general, but not limited to, the total tunnel barrier thickness, is generally constrained, although not limited to, less than or equal to 10 nm." Page 15, lines 3-6. Therefore, the aggregate thickness of layers 60, 65, and 70 can be 0 nm, which would place the top injector layer and bottom injector layer in direct contact.

Thus, Applicants disclose, and the Specification supports, embodiments of the present invention having a top injector layer formed in direct contact with the bottom injector. Referring to Fig. 1, the aggregate thickness of layers 60, 65, and 70 may be less than 10 nm. This range includes a thickness of 0 nm, in which case the top injector layer 80 and the bottom injector layer 50 are in direct contact. Applicants maintain that neither the

Specification nor the Figures limits the claimed subject matter to the top injector layer not being in direct contact with the bottom injector layer. Thus, Applicants maintain that claims 54-57 are not indefinite. If the scope of the subject matter embraced by the claims is clear to a person of ordinary skill in the art, then the claims are not indefinite. MPEP 2173.04. Definiteness of claim language must be analyzed, not in a vacuum, but in light of the content of the particular application disclosure. MPEP 2173.02. Applicants maintain that one skilled in the art would know that the aggregate thickness of the tunnel barrier and the spacers may be 0 nm, and that the top injector layer and the bottom injector layer, in this instance, are in direct contact, in view of the Specification cited above.

Further, in determining indefiniteness, the focus is "whether the claim meets the threshold requirements of clarity and precision, not whether more suitable language or modes of expression are available." MPEP 2173.02. Applicants maintain that the claimed features meet the test for clarity and precision in light of the Specification and the preferred embodiments discussed above. Thus, Applicants maintain that that the language of claims 54-57 is clear and definite because it provides a clear warning to others as to what constitutes infringement of the claim. A rejection under Section 112, second paragraph, is appropriate only

"[i]f the language of the claim is such that a person of ordinary skill in the art could not interpret the metes and bounds of the claim so as to understand how to avoid infringement." MPEP 2173.02. One skilled in the art can interpret the top injector layer and the bottom injector layer being in direct contact when the tunnel barrier layer and the spacer layers have an aggregate width of 0. Thus, the features of claims 54-57 are supported by the Figures, and are not indefinite.

Regarding claim 56, the Office Action alleges that the phrase "a quantum well is formed adjacent to, but not necessarily in direct contact with, the bottom injector layer and the tunnel barrier" is allegedly unclear because the Figures show that a quantum well is formed in direct contact with the bottom injector layer, but not the tunnel barrier. Office Action, page 3, lines 3-6. Applicants respectfully traverse. As noted above, the thickness of spacers between the quantum well and the tunnel barrier may be 0nm, which would provide place the quantum well in direct contact with the tunnel barrier. Thus, this feature of claim 56 is not indefinite.

Regarding claim 57, the Office Action alleges that the phrase "a first quantum well is formed adjacent to, but not necessarily in direct contact with, the bottom injector layer and the tunnel barrier" and "a second quantum well is formed adjacent to, but not

necessarily in direct contact with, the top injector layer and the tunnel barrier" is allegedly unclear because the Figures show that first and second quantum wells are formed in direct contact with the bottom and top injector layers, but not the tunnel barriers. Office Action, page 3, lines 7-12. Applicants respectfully traverse. As noted above, the thickness of spacers between the quantum wells and the tunnel barrier may be 0nm, which would provide place the quantum wells in direct contact with the tunnel barrier. Thus, these features of claim 57 are not indefinite.

Further regarding claims 54-57, the Office Action alleges that the phrase "the bottom injector and top injector layers forming a p-n junction" is allegedly unclear as to how to form the p-n junction between the bottom injector and top injector layers because the top injector is separated by an offset from the bottom injector. Office Action, page 3, lines 13-16. Applicants respectfully traverse.

As noted above, the bottom and top injector layers may be in direct contact with each other according to the Specification. Further, the Specification supports the bottom injector layer and top injector layer forming a p-n junction. For example, "the 'top' may refer to an n-type material concurrent with 'bottom' referring to a p-type material, or alternatively 'top' may refer to a p-type layer concurrent with 'bottom' referring to an n-type layer." Page

12, lines 26-28. Further, the Specification recites "the term layering includes, but is not limited to, depositing, oxidizing, converting, or growing and further does imply direct contact of any kind." Page 12, lines 28-30. Thus, the Specification clearly supports the claimed feature, and Applicants maintain it would be clear to one skilled in the art how to have the bottom injector and the top injector layers forming a p-n junction.

Claim 83

Regarding claim 83, the Office Action alleges that the phrase "at reduced substrate temperature" is vague and indefinite because the reduced substrate temperature is not provided. Applicants respectfully traverse.

A claim is not indefinite if "those skilled in the art would understand what is claimed when the claim is read in light of the specification." MPEP 2173.02; *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1576, 1 USPQ2d 1081, 1088 (Fed. Cir. 1986). If one skilled in the art is able to ascertain the meaning of the terms in the claim in light of the specification, then Section 112, second paragraph, is satisfied. MPEP 2173.02. Applicants submit that one skilled in the art would be able to ascertain the term "at reduced substrate temperature" in light of the specification.

For example, values and ranges of preferred reduced substrate temperatures can be found in the Specification on page 15, line 20, to page 16, line 26. Further, claims 84 and 85 depend from claim 83, and recite specific temperatures. Thus, Applicants maintain that one skilled in the art would understand what is claimed with regard to reduced substrate temperatures when claim 83 is read in light of the Specification. Applicants respectfully request that the Examiner withdraw the indefiniteness rejection of claims 83-85.

Although Applicants address the outstanding rejections of claims 54-83 under Section 112, second paragraph, by referencing the disclosure, the above discussion should not be relied upon to unduly limit the scope of the presently pending claims, which instead should be given their broadest reasonable interpretation. Further, Applicants do not concede that the rejections under Section 112 are proper. Claims 54-83 meet the statutory requirements of Section 112, and are, at most, objectionable.

Anticipation

Claims 74 and 83-85 are rejected as allegedly anticipated by Gennser. Applicants respectfully traverse.

To anticipate, the applied art must disclose each and every element of the claimed invention. Applicants submit that Gennser does not disclose each and every element of claims 74 and 83-85.

Gennser relates to resonant tunneling of holes through silicon barriers. Gennser describes molecular-beam epitaxy grown Si/SiGe hole resonant tunneling devices consisting of an unstrained SiGe quantum well between two strained Si barriers. Because the band gap difference between Si and SiGe manifests itself mainly in the valence band, it is favorable to employ hole tunneling. Gennser describes an undoped tunneling structure consisting of a quantum well surrounded by barriers and spacer layers of varying thickness was grown at 390 °C.

Referring to Figure 1(a) of Gennser, the quantum wells are located in the valence band. Two light hole states and four heavy hole states exist in the quantum well. At most, Gennser describes intraband diode tunneling. Gennser does not disclose a method of fabricating an interband tunnel diode.

In contrast, claims 74 and 83 recite "[a] method of fabricating an interband tunnel diode having a p-n junction." The Office Action alleges that Gennser discloses "a method of fabricating an (sic) tunnel diode by growing (sic) at least quantum well epitaxially at temperature 390 °C." Applicants note that claims 74 and 83 recite fabricating an interband tunnel diode, not an intraband tunnel diode. Applicants submit that this distinction is significant, and that Gennser does not disclose fabricating an interband diode.

Further, Gennser does not disclose a p-n junction. Referring to Figure 1 of Gennser, only unipolar transport of electrons is described. Thus, for at least these reasons, Gennser does not disclose each and every element of independent claims 74 and 83. Applicants respectfully request that the Examiner withdraw the anticipation rejection of claims 74 and 83-85

Obviousness

Claims 75-82 are rejected as allegedly rendered obvious by Gennser in view of Larsen. Applicants respectfully traverse the rejection.

To establish obviousness, the Office Action must meet three basic criteria. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the references or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art references must teach or suggest all the claimed limitations. MPEP 2143. Applicants submit that the Office Action fails to establish obviousness with respect to claims 75-82.

Applicants submit that the applied art, either alone or in combination (assuming the references can be combined, which Applicants do not admit), does not disclose or suggest all the

claimed limitations. Applicants note that claims 75-82 all depend directly or indirectly from independent claim 74. As discussed above, Gennser does not disclose all the features of claim 74. Applicants submit that Larsen does not disclose or suggest those features of claim 83 missing from Gennser.

Larsen relates to growing relaxed $\text{Si}_{1-x}\text{Ge}_x$ alloy layers of high-crystalline quality with well-defined buried layers doped with impurities with regard to vacancy-mediated diffusion. Larsen describes sample structures made by molecular beam epitaxy on oriented Si substrates using the compositional grading technique. Larsen describes the substrates as consisting of an undoped graded buffer layer on which a layer of SiGe with a constant Ge content is deposited including a thin, buried Sb doped layer.

Larsen describes the sample structures being heated in a high purity flow furnace using an argon ambient with the temperature monitored as a function of time in order to obtain a precise temperature-time set. Temperatures between 729 and 1028 °C were used for times between 20 minutes and 24 hours. Larsen describes the diffusivity of Sb in $\text{Si}_{1-x}\text{Ge}_x$ as a function of Ge alloy to be time and concentration independent over the investigated Ge-concentration range and described with a single diffusion coefficient. Further, Larsen describes that the extracted activation energies for diffusion have a Ge-content dependence that

is sublinear. Larsen, however, does not disclose or suggest fabricating an interband tunnel diode having a p-n junction by heat treating, during or after growth of the layers in the interband tunnel diode.

In contrast, claim 74 recites a method of fabricating an interband tunnel diode having a p-n junction by heat treating, during or after growth of the layers in the interband tunnel diode. The Office Action alleges that Larsen teaches "heat treatment in a high flow furnace using an argon ambient with the temperature monitored as a function of time in order to obtain a precise temperature-time set. This aspect of Larsen, however, fails to disclose or suggest those features of claim 74 missing from Gennser. Specifically, Larsen does not disclose or suggest fabricating an interband tunnel diode having a p-n junction.

Larsen does not disclose or suggest an interband tunnel diode in determining the diffusivity value and temperature-time sets. The heat treatment of Larsen results in diffusing the dopants, not fabricating an interband tunnel diode having a p-n junction. This aspect of Larsen does not disclose or suggest Applicants' claimed invention.

Further, the Office Action does not provide any evidence of a motivation to combine the applied art, either in the applied art, or in the knowledge generally available to one of ordinary skill in

the art. Larsen describes heat treating sample structures of Si for various temperatures and periods to determine diffusivity. Applicants submit that one skilled in the art would not be motivated to combine Larsen with Gennser, which describes resonant tunneling of holes through silicon barriers at low temperatures. Gennser describes two distinct resonances to tunnel through heavy and light holes states at lower temperatures than those taught by Larsen. Applicants fails to see why one would be motivated to combine the applied art in view of these differences of temperatures.

Moreover, claims 75-82 depend from claim 74, which is not alleged to be rendered obvious by the applied art. If an independent claim is not obvious, then any claim depending from the independent claim is not obvious. MPEP 2143.03. Applicants submit that claims 75-82 are not rendered obvious by the applied art for at least these reasons. Applicants respectfully request that the Examiner withdraw the obviousness rejection.

Conclusion

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact William F. Nixon (Reg. No. 44,262) at the telephone number of the undersigned below, to conduct an interview

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in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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